Lost to follow-up: A potential under-appreciated limitation of endovascular aneurysm repair

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Objective: **It has long been evident that lifetime follow-up after endovascular aneurysm repair (EVAR) is necessary to identify late complications. The purpose of this study is to test the hypothesis that late follow-up rates for EVAR in routine practice are inferior to those reported from protocol-driven clinical trials, consequently contributing to avoidable events associated with poor long-term outcome.**

Methods: **From February 1999 to December 2005, 302 EVARs were performed and eligible for follow-up. Of these, 47 were performed as part of an industry-sponsored clinical trial (study patients). Responsibility for follow-up was assigned to a research nurse for study patients and to office clerical staff for nonstudy patients. Follow-up compliance was classified as either frequent (<1 missed scheduled appointment) or incomplete (>2 missed scheduled appointments). Overall survival and complication rates were analyzed.**

Results: **Of the 302 patients, 203 (67.2%) had frequent follow-up and 99 (32.8%) had incomplete follow-up. The mean follow-up was significantly better in the frequent follow-up group (34.7 ± 22 months) vs the incomplete follow-up group (18.8 ± 18.6 months, $P < .001$). The 5-year survival (63.9% frequent vs 64.0% incomplete), the 5-year reintervention rate (22.3% frequent vs 10.8% incomplete), and incidence of known endoleak (14.8% frequent vs 9.1% incomplete) were statistically similar in the two groups. The incidence of major adverse events, defined as events requiring urgent surgical intervention, was significantly increased in the incomplete follow-up group (6.1% vs 0.5%; $P = .006$), with nearly half of these patients dying perioperatively. There was no difference in measured outcomes for study patients compared with nonstudy patients. However, mean follow-up was significantly longer for study patients vs nonstudy patients (44.8 ± 23.7 months vs 26.8 ± 20.9 months; $P < .001$).**

Conclusions: **Follow-up surveillance after EVAR is less intense in practice environments outside of clinical trials. Patients with incomplete follow-up have higher fatal complication rates than patients with frequent follow-up. These data expose a potential under-appreciated limitation of EVAR, questioning whether the findings in clinical trials defining the efficacy of EVAR can be routinely extrapolated to ordinary practice. (J Vasc Surg 2007;46:434-41.)**

Since the original description by Drs Parodi, Palmaz, and Barone in 1991, endovascular aneurysm repair (EVAR) has progressively become the preferred method of treatment for patients with abdominal aortic aneurysm (AAA).[1] A continued shortcoming of EVAR is endoleak, a complication that occurs over the life of the graft in 25% to 47% of cases.[2] Fortunately, endoleak is relatively easy to diagnose and can usually be corrected by endovascular techniques. The sporadic nature of this complication requires standardized and vigilant follow-up with postoperative imaging for the life of the patient.[2-6] The long-term success of EVAR therefore depends on conscientious patient follow-up.

Clinical trials have shown that the efficacy of EVAR is comparable with traditional open AAA repair; however, these trials usually take for granted that patient treatment is standardized and follow-up is complete.[7-9] In reality, 100% patient follow-up compliance is extraordinarily difficult to attain; in fact, it has been shown that patients routinely will resist follow-up evaluation if left to their own desires.[10] Investigators of clinical trials have long appreciated this and thus usually recruit special research nurses and staff dedicated to manage patient follow-up and study registration. This requires resources not routinely found in the offices of community-based surgeons in private practice. This raises a question regarding completeness of standardized follow-up for EVAR in such settings. True follow-up compliance rates are not known in situations devoid of the oversight and management provided by dedicated research nurses.

The purpose of our study, therefore, was to test the following hypotheses:

- Post-EVAR follow-up of patients in practice settings without clinical trials is inferior to follow-up where patients are enrolled in managed studies,
- Outcomes for patients with incomplete follow-up are worse than those for patients with frequent follow-up, and
- Outcomes for patients involved in routine practice surveillance are inferior to those of patients enrolled in clinical trials.

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METHODS

We tested our hypotheses by reviewing the results of 310 consecutive EVARs performed at our institution from February 1999 to December 2005. Of these, 302 patients survived and were eligible for follow-up. Table I summarizes the demographics of these 302 patients. Treatment in 47 (15%) of the 302 patients was within the protocol guidelines of industry-sponsored clinical trials.

All procedures were performed by a fellowship-trained vascular surgeon or an interventional-trained vascular internist within the same practicing group of physicians. All patients whose aneurysms were >5 cm were evaluated for repair. Patients aged >64 years with anatomy suitable for EVAR were preferentially offered EVAR. Favorable anatomy for EVAR included an infrarenal neck ≥15 mm, an aortic luminal diameter ≤27 mm, and aortic angulation ≤60°.

Procedures were performed using a bilateral, transfemoral approach in a dedicated operative suite with fixed fluoroscopic equipment. Intravascular ultrasound (IVUS) imaging was used to confirm technically successful graft placement and therapeutic success. The specific type of graft used was determined by the preference of the attending physician. All patients were free of type I endoleaks at the time of discharge.

All patients were prospectively enrolled in a vascular database at the time of their procedure. The postoperative follow-up regimen was determined by whether the patient was enrolled in a clinical trial. Patients not on study protocols were followed up using a postoperative surveillance regimen of an office visit with imaging at 1 week, 1 month, every 6 months for 2 years, and then yearly for life. The importance of follow-up was stressed to each patient before discharge by the nursing staff and the attending physician.

The initial imaging modality was duplex ultrasound. All patients with enlarging aneurysmal sacs or obvious ultrasonic flow outside the endoluminal prosthesis underwent computed tomography (CT) angiography, contrast angiography, or both. All endoleaks were preferentially repaired using endovascular techniques. Open repair was used as needed.

Patients in industry sponsored clinical trials were followed up in accordance with the individual study protocols. Follow-up consisted of an abdominal contrast CT scan and plain abdominal radiographs (flat, upright, lateral, and oblique) at 1, 6, and 12 months, and then yearly. The follow-up regimen was generally similar to the regimen just outlined; however, dedicated clinical trials nurses were involved to manage the follow-up of each study patient. Each of the patients in the trials was frequently contacted by telephone and follow-up compliance was carefully monitored.

For patients not on a study protocol, missed office appointments were noted by our IDX office software (IDX Systems Corp, Seattle, Wash) and were rescheduled by office clerical personnel. If personal verbal communication was not made, telephone messages were left about a replacement appointment. If repeated attempts to obtain office follow-up for the patient were unsuccessful, then a certified letter was mailed to the permanent home address informing the patient of the need for office follow-up. If the patient chose not to come for follow-up after delivery of the certified letter, no further attempts to obtain follow-up were made.

Table I. Demographics of 302 consecutive endovascular aneurysm repair patients

Demographic	*Value, n or mean ± SD*
Age, years (median)	74.7 ± 7.7 (75.5)
Race	
White	286
Minority	16
Gender	
Male	261
Female	41
Treated in industry-sponsored clinical trial	47
Treated in routine practice	255
Prosthesis used	
AneuRx (Medtronic, Minneapolis, Minn)	139
Excluder (W. L. Gore, Flagstaff, Ariz)	130
Zenith (Cook, Bloomington, Ind)	27
Powerlink (Endologix, Irvine, Calif)	6

For those enrolled in a clinical trial, dedicated research nurses performed all office and diagnostic follow-up scheduling. As a general policy, all patients who missed a scheduled follow-up appointment were contacted by a research nurse by telephone. Important clinical information was gleaned and the need for diagnostic testing and follow-up stressed. Using this approach, all 47 of the study patients were in regular telephone contact with the research nurses.

For the purpose of this study, we defined incomplete follow-up as any patient who missed two or more consecutive follow-up office visits. All other patients were defined as having frequent follow-up. Next, we retrospectively reviewed the charts of all 302 patients and determined their follow-up status. Attempts were made to contact all patients who were lost to follow-up or whose follow-up care had been abandoned because of noncompliance by telephone calls and letters. A search was also performed of the statewide mortality database, the Social Security Death Index, and the obituary records of local newspapers. These techniques resulted in follow-up being re-established for all but 12 of the 302 patients. In the absence of concrete confirmation of mortality or known complication, these 12 patients were included in the analysis and assumed to be alive and complication free.

Outcomes for study patients were compared with outcomes for nonstudy patients, and outcomes for patients with incomplete follow-up were compared with outcomes for patients with frequent follow-up. Outcomes examined were mean follow-up, overall survival, need for reintervention, minor adverse advents (type I or II endoleak), and major adverse events, defined as complications where urgent operation was required or recommended, including

Table II. The types of devices and the number of complications by device

	Follow-up, n (%)				
	Frequent	*Incomplete*	*Study, n (%)*	*Nonstudy, n (%)*	*Complications, n (%)*
Patient total	203	99	47	255	7
AneuRx*	90 (44.3)	49 (49.5)	0 (0.0)	139 (54.5)	5 (71.4)
Excluder†	88 (43.4)	42 (42.4)	41 (87.2)	89 (34.9)	2 (28.6)
Zenith‡	21 (10.3)	6 (6.1)	0 (0.0)	27 (10.6)	0 (0.0)
Endologix§	4 (2.0)	2 (2.0)	6 (12.8)	0 (0.0)	0 (0.0)

*Medtronic, Minneapolis, Minn.
†W. L. Gore, Flagstaff, Ariz.
‡Cook, Bloomington, Ind.
§Endologix, Irvine, Calif.

Table III. Seven major complications occurring in 302 endovascular aneurysm repairs

Complication	*Months after EVAR*	*Intervention*	*Outcome*
Acute rupture	79	Open repair	Death
Acute rupture	40	Attempted endo repair/open repair	Death
Acute rupture	61	Open repair	Survived
Acute aneurysm expansion	72	Open repair	Death
Aortoduodenal fistula	33	Open repair	Survived
Symptomatic graft migration	34	Endo repair	Survived
Graft infection	58	None (patient refusal)	Survived

EVAR, Endovascular aneurysm repair.

aneurysm rupture, infected graft, and symptomatic endoprosthesis migration.

Kaplan-Meier life table analysis was performed to calculate survival and time to reintervention. The log-rank test was used to assess differences in these curves. The Student *t* test was used to compare means. Proportions were compared using the Fisher exact test. All analyses were performed using SAS 8 software (SAS, Inc, Cary, NC). Values of $P < .05$ were considered indicative of statistical significance.

RESULTS

The overall mean follow-up for all patients was 29.6 ± 22.3 months (median, 26 months). The mean follow-up for patients in the frequent follow-up group was 34.7 ± 22 months and the mean follow-up for the incomplete follow-up group was 18.8 ± 18.6 months ($P < .001$). For the entire series, endoleaks developed in 39 patients (12.9%), 41 patients (13.5%) required reintervention (angio/coil, n = 23; open repair, n = 7; proximal extender, n = 4; distal cuff, n = 3; miscellaneous interventions, n = 4), and a major complication developed in seven patients (2.3%), three of which resulted in death. Table II summarizes the types of device used and the complications by device. The major complications and outcomes are summarized in Table III.

As defined by the study, frequent follow-up was achieved in 203 (67.2%) of the 302 patients analyzed, and 99 (32.8%) received incomplete follow-up. Frequent follow-up was achieved in 169 (66.3%) of the 255 nonstudy patients, and 86 (33.7%) had incomplete follow-up. Of the 47 study patients, 34 (72.3%) achieved frequent follow-up, and 13 (27.7%) experienced incomplete follow-up. A total of 52 patients had EVAR ≤1 year (1 study patient, 51 nonstudy patients; 46 patients with frequent follow-up, and 6 with incomplete follow-up). No patients in the study or nonstudy cohort failed to keep at least one follow-up visit. Patients who received EVAR were typically older patients (71 were octogenarians), some of whom lived in assisted-living facilities.

The Greenville Hospital System University Medical Center is a tertiary facility serving a catch area of 1.2 million people. More than 90% of EVAR patients resided ≤50 miles of the hospital.

Although the follow-up rate for nonstudy patients compared with study patients was not statistically different ($P = .5$), the mean follow-up was better in the study group patients than in the nonstudy group patients (44.8 ± 23.7 months vs 26.8 ± 20.9 months, $P < .001$). Of the 13 study patients defined as having incomplete follow-up, 10 were patients who were in regular contact with the research nurses by phone but who were physically and logistically unable to return for regular outpatient evaluation or outpatient testing. One patient remained in regular contact with the research nurses by phone but simply refused to come for follow-up. The two remaining patients were lost after the clinical trial closed.

In examining the outcomes of patients with incomplete follow-up compared with patients with frequent follow-up, no statistically significant difference was found in survival

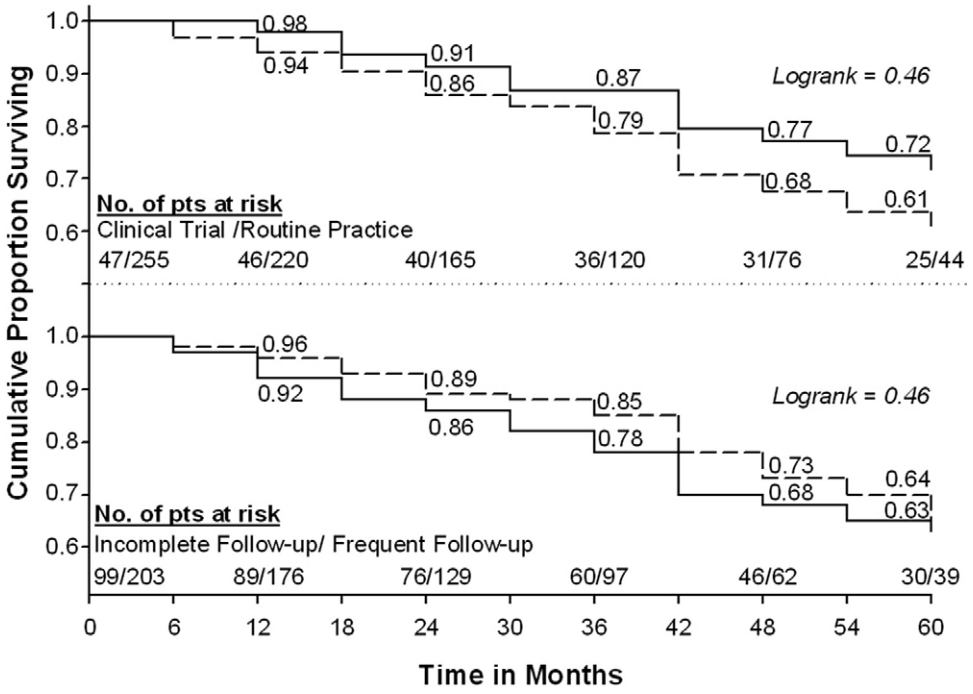

Fig 1. Upper graph, Survival for patients in a clinical trial *(solid line)* vs those in routine practice *(dashed line)* and **(lower graph)** for patients with incomplete follow-up *(dashed line)* vs those with frequent follow-up *(solid line)*.

(Fig 1) or need for reintervention (Fig 2). The incidence of known endoleak was statistically similar as well, at 30 (14.8%) for frequent follow-up patients vs nine (9.1%) for incomplete follow-up patients ($P = .2$). However, patients with incomplete follow-up experienced a significantly higher rate of late major complications (n = 1 [0.5%] for frequent follow-up vs n = 6 [6.1%] for incomplete follow-up; $P = .006$).

In examining the outcomes of study patients compared with nonstudy patients, no statistically significant difference was found in survival (Fig 1) or need for reintervention (Fig 2). The incidence of known endoleak was statistically similar as well, at 33 (12.9%) for nonstudy patients vs six (12.8%) for study patients ($P = 1$). Although the incidence of major complication was similar in both groups, at 2.4% for the nonstudy group (n = 6) vs 2.1% (n = 1; $P = 1$), it is important to note that the only major complication in the study group occurred in a patient who became lost to follow-up after the protocol-mandated follow-up ceased. This patient required emergency open operation for acute aneurysmal expansion from a presumed endoleak and subsequently died.

Eight aneurysm-related deaths (2.6%) occurred. One study patient (2.4%) and four nonstudy patients (1.6%) died ≤30 days of repair. Although only one study patient (2.4%) and 2 nonstudy patients (0.8%) died of late complications related to their aneurysm, it should be noted that each of these patients had incomplete follow-up.

DISCUSSION

EVAR has become a mainstay in the arsenal of the vascular surgeon. Studies have established EVAR efficacy to be comparable with traditional open AAA repair.[11-13] However, known postoperative complications of EVAR, including endoleak, graft migration and failure, and persistent increase in aneurysmal diameter—which can cause rupture—must be identified by obligatory postprocedural follow-up imaging surveillance.[2,9,14,15] Although studies have demonstrated that vigilant postoperative surveillance can adequately detect late postoperative complications consequent to EVAR, resources associated with such rigorous surveillance protocols are not routinely available to the practicing vascular surgeon not participating in clinical trials.[7,15] The obvious question then arises: can the typical practicing vascular surgeon, working to minimize overhead costs, achieve comparable follow-up to that of the published trials? If not, then what is the impact of incomplete follow-up?

The issue of post-EVAR follow-up protocol compliance has received little attention in the literature. For example, the original studies by Zarins et al[16] examining the outcomes after placement of the AneuRx (Medtronic, Minneapolis, Minn) endoluminal aortic prosthesis failed to address patients lost to follow-up and inferred that complete 4-year follow-up was obtained for all 1192 patients enrolled in the trial. The outcomes of this study launched the wholesale use of the AneuRx device into clinical practice.

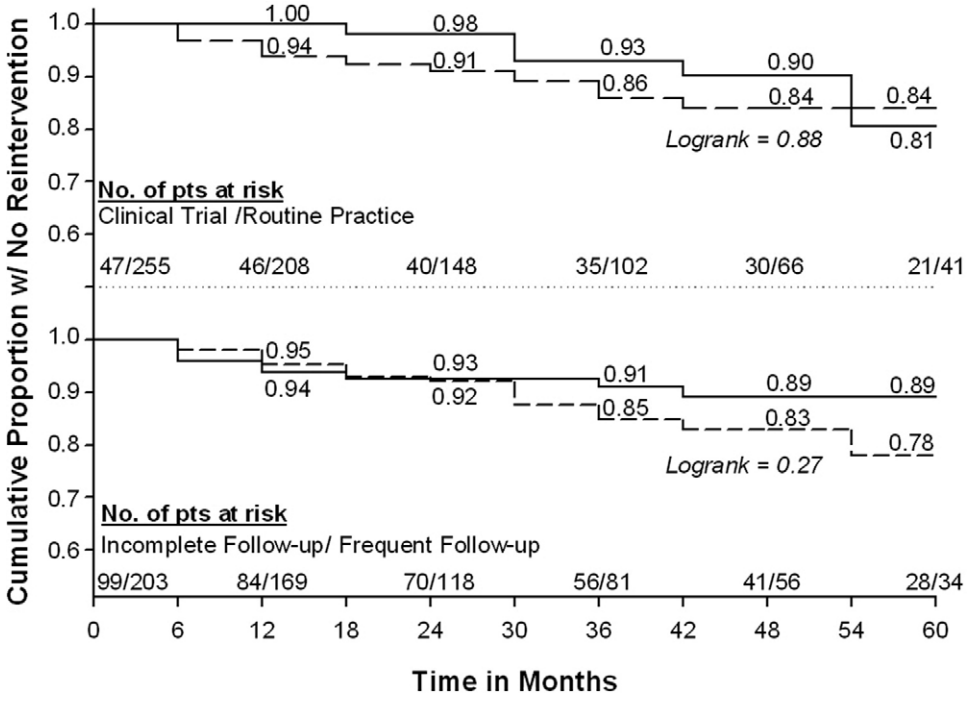

Fig 2. Upper graph, Reintervention for patients in a clinical trial *(dashed line)* vs those in routine practice *(solid line)* and **(lower graph)** for patients with incomplete follow-up *(solid line)* vs those with frequent follow-up *(dashed line)*.

Perhaps a truer depiction of reality, however, was conveyed in a study by Leurs et al[17] in a study of 4433 patients who underwent EVAR between 1996 and 2004 in the European Collaborators on Stent-Graft Techniques for AAA and Thoracic Aortic Aneurysm and Dissection Repair (EUROSTAR) trial. Only 35% of patients in this trial presented for all scheduled appointments. Statistical analysis found that patients with more comorbidities (ie, current smokers, hyperlipidemia, and general unfitness for open AAA repair) were more likely to comply with surveillance. Despite closer follow-up, these patients still had increased rates of complications and death. Although the authors questioned the follow-up regimen itself and identified patient factors associated with poor compliance, they stopped short of examining the clinical impact of inadequate follow-up.[17] We, therefore, undertook our study to examine this impact further.

Based on knowledge from literature and our own clinical intuition, we formed three hypotheses:

First, we postulated that study patients in our practice, because of attention given by the research nurses, had superior follow-up compared with patients not enrolled in clinical trials.

Second, we postulated that patients who were compliant with frequent follow-up surveillance had superior outcomes compared with those with incomplete follow-up.

Third, assuming the first two hypotheses to be true, we postulated that study patients had superior outcomes compared with nonstudy patients.

In examining the first hypothesis, we found no significant difference in overall follow-up rates for study patients compared with nonstudy patients. We did, however, find that study patients had a longer overall mean follow-up compared with nonstudy patients. It is worth mentioning that some of our earliest EVAR patients were study patients, perhaps explaining why mean follow-up was longer in this group; however, a large number of nonstudy patients were also operated on early. We believe that the longer overall mean follow-up is more accurately a reflection of the diligent persistence of our research nurses than that of temporal bias.

In contrast, we believe follow-up rates in the study group were skewed by two patients who maintained frequent follow-up during the surveillance period mandated by the clinical trial but quit coming for surveillance as soon as the trial was complete. One of these patients later had a major adverse event resulting in death.

Of interest was that our clinical trials nurses achieved 100% contact with every study patient during the protocol follow-up period. For various reasons, there was a group of study patients who either refused or were logistically unable to return for follow-up. Despite this, clinical information was gleaned by the research nursing team that more than likely resulted in clinical benefit for the patients. This serves to highlight that patients are sometimes unable or unwilling to participate in their own follow-up even under rigorous circumstances.

In examining our second hypothesis, we found that patients with incomplete follow-up experienced a signifi-

cant increase in major complications compared with patients with frequent follow-up. Patients with incomplete follow-up had a 6% major complication rate resulting in a mortality rate of 43%.

In examining our third hypothesis, we could demonstrate no difference in outcome between the study patients and the nonstudy patients. Although these findings disproved our third hypothesis, we believe that these same findings failed to confirm the null hypothesis because of the unexpected number of study patients in the study group who had incomplete follow-up.

Our study suggests that "lost to follow-up" is a major problem for patients undergoing EVAR and demonstrates a potential unappreciated limitation of this treatment modality. These findings are concerning, but they could have been worse. Despite our best efforts, 12 patients were unable to be located and, for our analysis, were assumed to have no new adverse events after their last follow-up appointment; however, one could reasonably speculate that endoleaks developed in some, and their EVAR-treated aneurysms may have ruptured. By assuming that all of these patients had no subsequent complications after being lost to follow-up, we are giving a best-case scenario for the outcomes of these patients. When taking into consideration that the median follow-up for the entire cohort is just more than 2 years, it can be speculated that our eventual incidence of adverse events will be markedly different than that depicted by this study.

The implications of this report are that EVAR has been released as an efficacious therapy from results of clinical trials that have failed to document risks associated with lack of patient compliance with life-long surveillance. We were quite disturbed to learn that one third of our patients, by definition, received incomplete follow-up. Our findings imply that there are patients throughout the country who are not receiving recommended follow-up surveillance and who are at risk for a major complication. Information from published clinical studies looking at EVAR fails to emphasize this as a shortcoming of the treatment.

Although we did not analyze our 99 patients who had incomplete follow-up to determine characteristics that may predispose them for follow-up noncompliance, our study does suggest that patients at risk for poor follow-up should be identified and advised against EVAR. It may be instructive to remember that bariatric surgeons have long been sensitive to the risks associated with treating patients likely to be noncompliant with follow-up. As a consequence, preoperative patient selection screening and committed life-long follow-up have proven to be at least as important as the operative procedure itself for patients with morbid obesity. It may well be that such measures should be instituted as part of the mandatory overall EVAR treatment regimen.

The concept of clinical trial bias, where clinical outcome after treatment is enhanced by the artificial environment created by the study itself, is not new. Mor et al[10] found that outcomes can be substantially determined by the intrinsic trial infrastructure and not the treatment per se. They demonstrated that availability of a nurse 24 hours a day or that a study is multicenter or single institutional in nature may highly influence outcome.[10] Influence of clinical trials bias on EVAR outcomes, although a legitimate concern, is undetermined. Clearly, this phenomenon should be considered whenever outcomes are being compared for patients treated in distinctively different environments.

Our study does have several limitations. It is a retrospective study, leaving the results open to various selection biases. The numbers are relatively small, especially in the study group cohort, which could result in type II statistical error. Multi-institutional studies are clearly needed to corroborate our findings and to determine which patients are at particular risk for noncompliance.

CONCLUSION

Approximately one third of all EVARs performed at our institution had incomplete follow-up. Poor patient compliance with follow-up surveillance was associated with a statistically significantly higher incidence of major late complications after EVAR. Although outcomes for our patients involved in clinical trials were similar to those of our nonstudy patients, this was likely due to the unexpected lack of difference in follow-up rates for nonstudy vs study patients. This report exposes a previously unappreciated potential limitation of EVAR and suggests that results in published clinical trials may not represent what is attainable for patients treated with EVAR in a more casual practice setting. The necessity of strict adherence to postoperative surveillance protocols needs to be stressed. Although further corroboration is necessary, it can probably be concluded that EVAR should be avoided in patients likely to be noncompliant with critical follow-up surveillance protocols.

AUTHOR CONTRIBUTIONS

Conception and design: WJ, ST, EL, BG, JY
Analysis and interpretation: WJ, ST, CK, CJ, DB
Data collection: WJ, CK
Writing the article: WJ, ST
Critical revision of the article: WJ, ST, CK, CJ, DB, EL, BG, JY
Final approval of the article: WJ, ST, CK, CJ, DB, EL, BG, JY
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Overall responsibility: ST

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DISCUSSION

Dr R. James Valentine, (Dallas, Tex). I congratulate the authors on an interesting and provocative study. Endoleaks and other problems are expected in a minority of patients who have had endovascular aneurysm repair (EVAR). Most of us have assumed that patients will be compliant with follow-up as a condition of placing these devices. In this retrospective study, however, the authors found that a third of their EVAR patients did not comply with an established follow-up routine. The authors' most important finding is that there were significantly more major adverse events in the patients with inadequate follow-up compared to those with complete follow-up. This clearly demonstrates that the long-term success of EVAR is dependent on compliance with a monitoring program. As the authors suggest, these findings might be representative of a real problem on a national level.

One might object to the notion that the Greenville Hospital System represents the general practice of vascular surgery in the US. However, it is difficult to argue with the authors' conclusion that long-term follow-up for EVAR is considerably worse outside of controlled clinical trials. The addition of a full-time clinical research nurse did not improve the follow-up, so we are left wondering whether the findings are a function of the patients in Greenville, South Carolina. This brings me to me first question. Where did the patients come from? Did distance from home to the hospital have an impact on follow-up compliance?

The data from the present study are remarkably similar to our findings in a VA study evaluating compliance with a watchful waiting program for small aneurysms.[1] We found that about a third of the patients did not return for repeat imaging studies, similar to the proportion of your patients who were lost to follow-up after EVAR. My second question is whether we might be able to predict poor compliance based on behavior before EVAR. Was there any indication that your patients missed appointments to follow aneurysms when they were smaller?

The findings in this study should send a message of caution: EVAR is clearly not appropriate for all patients. My final question is how are you going to integrate this information into your practice? Will you try to predict compliance as a condition of placing EVAR, and do you have any suggestions on how we can improve the compliance rate in general practice?

Dr Wesley B. Jones: With respect to the first question of where the patients come from in our patient population, the majority of our patients come within a 20-mile radius from our institution, at least 80%. It didn't appear that distance or geographic location was a factor in poor follow-up compliance.

With respect to the second question about patients with poor follow-up compliance in abdominal aortic aneurysms and if there is anything we could do to predict this poor compliance. Clearly, that was felt to be the next step from our study, and we didn't arrange the study for logistic regression to identify any associated patient variables that may be associated with poor follow-up compliance. This may bear a second study from us on this point. The crux of the problem was asymptomatic patients don't appear to feel like they need to go to the doctor and this has been shown time and time again previously.

With respect to the third question of what do we do next and how are we are going to integrate in our practice. We have discussed this and we feel that there are two ways to do this. One may be to take a page from bariatric surgery programs and preoperatively screen these patients aggressively for patients that would be well compliant, and those that we can identify preoperatively as being poorly compliant we would offer traditional open repair. The other opportunity would be a postoperative environment that would foster good follow-up compliance. One might even argue that financial incentives to the patient, such as breaks in their insurance costs or some kind of fiscal reward for actively participating in preventative care, may be an opportunity for improvement.

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INVITED COMMENTARY

Ronald L. Dalman, MD, *Stanford, Calif*

In the abdominal aortic aneurysm (AAA) endovascular repair (EVAR) post-procedural management paradigm, optimal graft surveillance methods and intervals for individual patients remain poorly defined. Many post-EVAR AAA patients undergo what in retrospect prove to be unnecessary, expensive, and potentially morbid imaging studies, whereas others experience sometimes catastrophic device-related events between prescribed imaging intervals.